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ABSTRACT

This study investigates science teachers' attitudes toward inquiry-based teaching and the influence of student participation in science activities on these attitudes. There were 45 teacher participants who taught upper elementary through high school. The three guiding questions of the study were: What are teachers' views of science inquiry? What are science teachers' beliefs about student learning? and Did the experience of participating in actual science inquiry motivate teachers to include more inquiry-based science in their classrooms? (Contains 18 references.) (YDS)

Science Teachers Attitudes

About

Inquiry-Based Science

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I. Science Teachers Attitudes About Inquiry-Based Science

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The purpose of this study is to examine the impact of student participation in an authentic science inquiry on the changing attitudes of a group of science teachers towards inquiry-based science. The project consisted of a number of authentic science inquiries, where the teacherís students participate in a series of connected investigations supported

by an internet conference. Forty-five teachers participated in the study. Data were collected from curriculum documents designed by the teachers, internet messages by the teachers, field notes from observation, and interviews with the teachers. The guiding questions for the study were: "What were teacher's view of science inquiry? "What were science teachers beliefs about student learning?" And "Did the experience of participating in actual science inquiry motivate the teachers to more inquiry-based science within their classrooms?"

Significance of Study: In a recent national survey of scientific literacy, the percentages of adult Americans correctly answering questions on three science sub-tests were disappointingly low. These sub-tests and the results were: understanding of scientific terms and concepts ...28.1%, understanding of the impact of science and technology... 49.9%, understanding of scientific processes of thinking... 12.1%. The lowest scores were associated with how science is conducted. When asked to describe what it means to study something scientifically, only a very few adults were able to give acceptable answers such as experimenting, testing hypotheses, or using systematic comparative studies (Miller, 1989). A National Assessment of Educational Progress (NAEP) student survey supports this finding and suggested that while facts could often be recalled, there was little evidence of understanding of the nature of science (Mullis, Dossey, Foerthch, Jones & Gentile, 1996; Mullis and Jenkins, 1988). These investigations and numerous others call for a review of how we deliver science education. Teaching behaviors and choices of course content influence the way science is viewed by students.

How students engage in science activities influence how and what they learn. Unfortunately in many secondary classrooms students do not have many opportunities for self-directed experience with phenomena. Several studies indicate a pattern of teacher-structured activities with students watching and listening for most of the lesson (Newton & Capie, 1981; Tobin, 1986; Tobin & Capie, 1982). At present, most secondary teachers do not understand the role of scientific inquiry as a means of allowing students to solve problems and thereby construct knowledge of science. Recent recommendations for science education reform (American Association for the Advancement of Science, 1993; National Research Council, 1996) assign major importance to the way students attempt to make sense of what they learn rather than to how teachers should deliver information.

A study by Songer and Linn (1992) points out the dangers of focusing science instruction too narrowly on facts or isolated pieces of scientific knowledge. They found that students rarely spontaneously integrated information presented in isolation and that instruction needs to focus students on constructing integrated understanding and support them in the process of developing these integrationís. In order for students to move beyond isolated ideas and into a more predictive and productive understanding of science, teacher intervention is necessary. Allowing students opportunities to actively participate in the collection of data, cooperative discussion of results and validation of their conclusions, as well as providing information and direction when needed, promotes a more complex understanding of science methods.

However, when teachers implement inquiry, they face a myriad of problems. They often feel that inquiries are too difficult to handle and overly time consuming; and that only high-ability students are successful. Along with this concern they are pressured with the idea that they must prepare students for upcoming assessments and that to accomplish this means teaching facts as opposed to developing understandings of concept, principles, and theories and the processes by which they are constructed (Blumenfeld et al., 1994; Ladewski et al., 1994.; Marx et al., 1994; Roth & Bowen, 1993; Welch, Klopfer, Aikenhead, & Robinson, 1981)

_Design and Procedure

The original study included 45 upper elementary through high school science classrooms. Teachers in these classes were interviewed and observed. Artifacts (lesson plans and projects) and email correspondence from both teachers and students were also collected. Teachers were questioned about their beliefs and attitudes towards science inquiry and learning. For this paper, we will describe the data from 12 of these classrooms.

The schools were located in suburban communities surrounding a large metropolitan city. Teachers experience ranged from two to 25 years in the classroom. One of the teachers teaches third grade, three teach 5th grade, two teach 6th grade, four teach 7th and 8th grade and two teach high school. Students at these sites were lower- to middle-class. The sites varied in diversity. A number of the inner city schools were primarily African American and Hispanic. None of the schools had student bodies composed of more than 80% Caucasian.

Findings

The guiding questions for the study were: "What were teacher's view of science inquiry? "What were science teachers beliefs about student learning?" And "Did the experience of participating in actual science inquiry motivate the teachers to more inquiry-based science within their classrooms?"

This group of teachers, even though interviewed separately, all defined authentic inquiry similarly. According to these teachers, authentic inquiry occurs when children are engaged in real life, open-ended problems that parallel the work that scientists do in their laboratories. As one teacher said, "Authentic science inquiry happens when students investigate something that is real life. It is not something that was made up so that students have an activity to do that uses the inquiry process."

When asked to identify the important components of this strategy, teachers stated projects should be:

ï Open-ended

ï Built on previous knowledge

ï Contain choices for students

ï Related to students lives

ï Problem based

ï Resource rich

The important components-- "Make as many real life connections as you can. Giving students opportunities to explore where everything is not completely set. There are some parameters so they have enough to go on, but they are given the freedom to really explore and come up with their own ideas of what to study."

Curiously, no one referred to the scientific method in these responses. As a result interviewers asked teachers to rank their perception of the usefulness of the scientific method as portrayed in science textbooks. The rankings ranged from 1 - 10 (1=not what scientists do, 10=exactly what scientists do). Half of the teacher's rankings were below 5. Teachers who responded with rankings below 5, gave explanations like the following: "It is often presented as 'THE' scientific method, and this is misleading, since there are an infinite number of ways to go about doing science in an organized way." "It is all fine and good to follow the steps, but science discoveries don't usually happen in such steps. I think kids should be allowed to discover, not just do something in a rote memorization manner." At the other end of the spectrum, teachers responded with: "It is the way scientists do science. I think the way people approach it and the way people sometimes define it might be a little different, but the basic process remains the same."

These responses seemed counter intuitive as all teachers agreed that engaging students in authentic inquiry was highly desirable. But further questioning elicited reasoning that cast these responses in a different light. Teachers saw the scientific method as presented in texts as limiting, linear, and difficult for students to transfer. Rather, they believed doing science was a recursive or cyclical process. As one teacher stated, "Maybe I'm seeing a static Step#1--Ask a question and Step#2--Form a hypothesis. I'd like to think of the scientific method not as a linear Step1, Step2, but a circular kind of reasoning. I think of it more as a cycle." Teacher's notions of circularity fit well with their previously identified important components of authentic inquiry and with research on science instruction (Songer and Linn, 1992).

Not surprisingly, these teachers also had similar views of how students acquire knowledge in the science classroom. Students were thought to construct knowledge as they interact with relevant, interesting, and challenging curricula. One teacher's statement captured the essence of their beliefs--"Hands on, minds on." Encouraging student initiated projects that involved systematic observations, data recording, and reporting were thought to be central. Teachers spoke of "creating an event" that stimulated curiosity and thus further study. Connecting students to meaningful problems, such as the Endangered Lake Fish (ELF) project, provided opportunities for each of the important learning factors to be realized. One teacher stated, "I would say that students learn best when they are building on their previous knowledge, asking questions, and making connections with things theyíve already learned."

Observations told a slightly different story. It was true that "hands-on" activities were used consistently. However, the focus on student directed, open ended inquiry was not as evident. Teachers had difficulty putting this view into practice. There were notable exceptions, however in general the only authentic science observed was connected to the ELF project. They were implementing the activities as we designed them, but only occasionally creating their own. In practice, many of the teachers continued to direct classroom discourse through lecture accompanied by activities. Teachers all stated they were currently incorporating more inquiry concepts into their practice. However the type of inquiry incorporated was generally teacher determined. In addressing this change effort we encouraged them to A) emphasis the open inquiry aspects of the scientific method more, and B) foster the resulting student initiated inquiry. Examples of the student projects that resulted included topics such as:

ï The fish motion & commotion relation to a variety of external actions

ï The fish reaction to new objects being placed in tank

ï The fish color change reaction to various stimuli

ï Common location of the fish in the tank throughout the class day ï Tank evaporation experiments

ï Cichlid reactions and behavior patterns

ï The fish reaction to various vegetation patterns in the tank

ï The fish reaction to various color backgrounds

ï The distance fish can see student feeder from the tank

ï A methodology to identify individual fish in the tank

ï Breeding variables of the Lake Victoria cichlids

ï Impacts of oxygen level in tank of introducing water hyacinth

These open inquiries, using the scientific method, were designed by the students for presentation at an Inquiry Day. It was obvious from the verbal explanation that accompanied the presentations that the students had developed solid understandings of how science is done from the experience.

Initial results of the teacherís view of how students acquire knowledge indicated a change of perception following the Inquiry Day presentations. Prior to the inquiries the majority of teachers expressed a view that the teacher determines most if not all content to be learned, how it should be delivered and was responsible for student learning. They felt that the textbook, worksheets and activities with pre-determined results led to success on traditional assessments. The remaining teachers felt that students needs some hands-on involvement to aid students in understanding science concepts but that generally this should be controlled by the teachers and only occasionally should students be allowed to have open-ended experiences. An apparent change in perception showed strongly in the post Inquiry Day interviews and questionnaires with most of the teachers recognizing the importance of open-ended inquiry in the acquisition and understanding of science knowledge. A number of the teachers based this changing view on their increased student interest and success during the inquiry experience . They stated that they "finally understood a concept" or had "never made that connection before."

Conclusion

Observations of the teacherís classroom practice indicated a difficulty in putting this newfound view into practice. They were fine in implementing the activities as we designed them but had difficulty designing their own. Initially many of the teachers continued to control a great deal of what went on in class through lecture and traditional testing. It is interesting to note that many of these same teachers stated both in follow-up interviews and on written questionnaires that they had made major change in the way they taught and were incorporating many inquiry concepts into their practice. Overall practice however did not match perception. It may be that we are dealing with an entrenched prior theory of practice that will be difficult to change without a great deal of additional effort. The more entrenched a belief, the harder it is to change the belief (Brewer & Chinn, 1991; Hewson, 1981; Posner et al, 1982; Vasniadou & Brewer, 1992). Thus in order to change this entrenched theory, it will be necessary to determine precisely why the theory is entrenched and what parts of the theory are more deeply entrenched. People sometimes adopt a new theory without fully comprehending it. Although understanding may be crucial for meeting certain goals, understanding may not be an indispensable prerequisite for belief change (Chinn & Brewer,1993).

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